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New trends in control and optimization in Smart City Networks (Submission Code: q1d9b)

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Abstract

In recent years, there has been a growing interest in sustainable and smart cities. Increasingly, cities need more efficient water, transportation, and energy systems to address various challenges, including a growing population, environmental and economic sustainability, and resiliency to natural disasters and unpredictable events. Advanced technologies for data collection, information processing, and decision-making are being developed, accompanied by advances in technologies for mitigating greenhouse gas emissions reduction such as renewables, electric vehicles, space heating, and industrial processes; all together these form the foundation for smart city networks and provide the focus for this special issue.

Typical examples of smart city networks are electrical distribution grids characterized by different nodes

and/or clusters of microgrids, and transportation networks in which links represent roads and nodes represent crossings. Often, these networks are interconnected and interacting, examples of which are charging stations for electric vehicles which couple power and transportation networks. District heating and electricity networks are often coupled, as are water distribution and district heating. In most of these networks, a common theme is an increasing shift towards solutions consisting of automation, digitalization, networking through the Internet of Things (IoT), thereby underscoring the need for developing tools for collecting, monitoring, and processing large amounts of data, analyzing and synthesizing real-time control algorithms, and carrying out studies that are scalable and are capable of handling emergencies.

The proposed Open Invited Track aims to collect new advances in the study of smart city networks, both from an application and methodological point of view.

Detailed description:

In recent years, there is a growing interest on sustainable and smart cities in which advanced technologies for data collection and elaboration are being developed together with technologies for mitigating greenhouse gas emissions reduction (such as renewables, electric vehicles, high efficiency production plants, etc.). Cities need more efficient water, transportation, and energy systems to address various challenges including a growing population, environmental and economical sustainability, and resiliency to natural disasters and/or unpredicted events. This Open Invited Track focuses on control and optimization of smart city-networks, which we define to connote networks of networks at multiple levels integrating multiple flows such as energy, physics, information.

Typical examples of smart city-networks are electrical distribution grids that are characterized by different nodes and/or clusters of microgrids, a transportation network in which roads represent links and crossings are nodes, communication networks, pipelines for water distribution systems, production and logistics systems distributed over the territory, buildings and microgrids that should be managed by an aggregator in the energy market, or combinations of such networks. Sometimes, such networks are interconnected and interacting: for example, charging stations for electric vehicles couple electric distribution and transportation networks, all physical networks are nowadays coupled with the communication network, water distribution and district heating, etc.

Several features are common to these networks. In many of these networks, there's an urgent concern related to sustainability, energy efficiency and low carbon footprint, which necessitate new tools, new methodologies, and new technologies. A typical example is a power network that includes renewable generation, storage systems, distributed and active loads (such as microgrids, electric vehicles, buildings, etc.), intelligent sensors and meters, and new market actors such as aggregators. Water networks are experiencing an evolution in terms of metering, monitoring, and remote control that open new challenges for advanced optimization and control approaches. Similar challenges are present in transportation, telecommunication, and natural gas networks. Another example is the need to understand the resilience properties of these networks when subjected to various hostile anomalies either due to natural disasters or adversarial cyber-attacks. In many cases,

interdependence between these networks can itself be leveraged to lead to efficient, optimal, or resilient operation.

The focus of this Open Invited Track is to assemble new advances in the study of Smart city-networks. Network control methods that enable optimization and resiliency constitute one example. The use of data-driven techniques, including many that are based on machine learning, is another. Graph-theoretic and game-theoretic solutions that help understand these networks and interface between these networks are essential. Tradeoffs regarding problems with Smart city-networks (such as resiliency and privacy, performance and computational complexity of various algorithms, etc.) need to be suitably characterized. Challenges precipitated due to large amounts of data and the scale of these networks need to be addressed. Both theoretical and practical explorations of this topic are necessary.

The Open Invited Track focuses on novel methods, models and tools to enhance the current state of the art in this area and on the application of these methodologies in learning and control problems arising in smart networks.

The topics of the proposed Open Invited Track are specifically related (but not limited to) to the following methods and application areas:

- Distributed control and optimization for city networks (traffic, transportation, water, energy, telecommunication, gas, smart grids, supply chains and production systems, etc.)
- Fault detection and state estimation of water, transportation and energy networks
- Machine learning-based control and optimization for city's networks
- Optimal control of city networks
- Control, optimization, and communication interconnected city networks.
- Resiliency and privacy of city networks
- Issues related to big-data and their connection to analysis and synthesis of efficient networks
- Cyber-physical security and cyber-physical human systems of large-scale networks
- Application to real city networks (water, energy, transportation, traffic, energy communities, etc.)
- Application to interconnected city networks (e.g., power grid and electric mobility, water networks and district heating, energy communities including smart buildings and distributed generation, integration with the ICT network, etc.)